

REMARKS

Claims 1-14, 17-33, 35-48 and 51-56 are pending in this application. Claims 1, 21 and 40 have been amended. No new matter has been introduced.

Claims 1-8, 10, 11, 13, 14, 17-24, 27, 29-33, 35-43, 46, 48, 49 and 51-56 stand rejected under 35 U.S.C. § 103 as being unpatentable over Wang et al. (U.S. Patent No. 5,607,874) ("Wang") in view of Yamazaki et al. (U.S. Patent No. 5,840,600) ("Yamazaki"). This rejection is respectfully traversed.

The claimed invention relates to a method of forming a composite barrier layer between a glass insulating layer and active regions of a memory device. As such, amended independent claim 1 recites a "method of forming an integrated structure" by *inter alia* "forming at least one gate stack structure over a substrate," "forming a source/drain region in said substrate on opposite sides of said gate stack structure" and "subsequently forming an oxide layer over said source/drain region, said oxide layer having a thickness of about 50 Angstroms to about 100 Angstroms and being formed by oxidizing approximately an upper surface of said source/drain region using atomic oxygen." Amended independent claim 1 also recites "forming a barrier layer in contact with said oxide layer."

Amended independent claim 21 recites a "method for forming a memory cell" by *inter alia* "forming a plurality of gate stacks over a substrate, each of said plurality of gate stacks comprising a gate oxide layer and a conductive layer," "forming spacers on sidewalls of each of said plurality of gate stacks" and "forming source/drain regions in said substrate on opposite sides of each of said plurality of gate stacks." Amended independent claim 21 also recites "subsequently forming a composite barrier layer over said source/drain regions, said composite barrier layer comprising an oxide layer formed by oxidizing approximately entire upper surfaces of said source/drain

regions using atomic oxygen, and a barrier layer formed over said oxide layer.”

Amended independent claim 21 also recites “forming a glass insulating layer in contact with said composite barrier layer.”

Amended independent claim 40 recites a “method of preventing the diffusion of atoms from a glass insulating layer in to a source/drain region formed between adjacent gate stacks of a memory device” by *inter alia* “forming spacers on sidewalls of said gate” and “subsequently forming a composite barrier layer over said source/drain region . . . said composite barrier layer comprising an oxide layer formed to a thickness of about 50 Angstroms to about 100 Angstroms by oxidizing approximately an entire upper surface of said source/drain region using atomic oxygen.” Amended independent claim 40 further recites “a barrier layer formed over said oxide layer.”

Wang relates to “a method for fabricating a T or Y shaped capacitor which has less photolithographic and etch steps than the conventional processes.” (Col. 2, lines 28-31). For this, Wang teaches the formation of several gate stacks over a substrate and of a source and drain region. (Col. 4). Wang also teaches the formation of an oxide layer (col. 5, lines 11-17) and of a barrier layer over source/drain regions. (Col. 5, lines 29-35).

Yamazaki relates to a method for “improv[ing] the characteristic properties of a silicon oxide film deposited by PVD or CVD.” (Col. 3, lines 11-13). For this, Yamazaki teaches the steps of “forming a thermal oxidation film by oxidation of silicon film at 500°-700° C. or . . . forming an insulating film composed mainly of silicon oxide which is deposited by PVD or CVD so as to cover island-like crystalline silicon, and then . . . annealing the resulting film at 400°-700° C. in a highly reactive atmosphere of nitrogen oxide which is photoexcited or photodecomposed by ultraviolet rays.” (Col. 3,

lines 14-21). In this manner, “[t]he thus modified silicon oxide film is used as the gate insulating film.” (Col. 3, lines 21-22).

The subject matter of claims 1-8, 10, 11, 13, 14, 17-24, 27, 29-33, 35-43, 46, 48, 49 and 51-56 would not have been obvious over Wang in view of Yamazaki. Specifically, the Office Action fails to establish a *prima facie* case of obviousness. Courts have generally recognized that a showing of a *prima facie* case of obviousness necessitates three requirements: (i) some suggestion or motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine the reference teachings; (ii) a reasonable expectation of success; and (iii) the prior art references must teach or suggest all claim limitations. See e.g., In re Dembiczak, 175 F.3d 994 (Fed. Cir. 1999); In re Rouffet, 149 F.3d 1350, 1355 (Fed. Cir. 1998); Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc., 75 F.3d 1568, 1573 (Fed. Cir. 1996).

First, neither Wang nor Yamazaki, whether considered alone or in combination, teaches or suggests all limitations of amended independent claims 1, 21 and 40. Neither Wang nor Yamazaki teaches or suggests “forming an oxide layer . . . having a thickness of about 50 Angstroms to about 100 Angstroms . . . by oxidizing an upper surface of said source/drain region using atomic oxygen,” as amended independent claim 1 recites. Wang and Yamazaki also fail to teach or suggest “forming a composite barrier layer . . . comprising an oxide layer formed to a thickness of about 50 Angstroms to about 100 Angstroms by oxidizing approximately an entire upper surface of said source/drain region using atomic oxygen,” as amended independent claim 40 recites.

As acknowledged in the June 7, 2004 Office Action, Wang is silent about forming an oxide layer by oxidizing an upper surface of a source/drain region using

atomic oxygen, much less about forming an oxide layer “having a thickness of about 50 Angstroms to about 100 Angstroms” by oxidizing approximately an upper surface of a source/drain region using atomic oxygen, as in the claimed invention. (Office Action at 2). In fact, Wang teaches that conformal insulating layer 22, which would arguably correspond to the oxide layer of the claimed invention, has a thickness “in the range between about 500 and 3000 Å” (col. 5, lines 15-17), and not “of about 50 Angstroms to about 100 Angstroms,” as in the claimed invention.

Similarly, Yamazaki is silent about “forming an oxide layer . . . by oxidizing an upper surface of said source/drain region using atomic oxygen” (claim 1) or about “forming a composite barrier layer . . . comprising an oxide layer . . . by oxidizing approximately an entire upper surface of said source/drain region using atomic oxygen” (claim 40). Yamazaki teaches thermal oxidation of a silicon film 703 to form a silicon oxide film 704. (Col. 30, lines 11-14). Yamazaki does not disclose, teach or suggest, however, the formation of an oxide layer “*by oxidizing an upper surface of said source/drain region using atomic oxygen*” or “*by oxidizing approximately an entire upper surface of said source/drain region using atomic oxygen,*” as in the claimed invention (emphasis added).

Applicants note that the Examiner’s assertion in the June 7, 2004 Office Action that “Yamazaki discloses forming an oxide layer by oxidizing the upper surface of the source/drain region using atomic oxygen (Column 12, Lines 14-27)” is incorrect. In column 12, lines 14-27, Yamazaki teaches only that “atomic oxygen and ozone (which are obtained by irradiating oxygen with ultraviolet rays for excitation, decomposition, and reaction) or excited oxygen molecules and nitrogen oxide molecules have a sufficiently long life and are capable of spatial movement under adequate conditions.” However, nowhere in column 12 of Yamazaki is it disclosed or suggested that the oxide layer is formed *by oxidizing the upper surface of a source/drain*

region, much less that the oxide layer is formed by oxidizing the upper surface of a source/drain region using atomic oxygen, as in the claimed invention.

In fact, Yamazaki *could not* disclose, teach or suggest “forming an oxide layer . . . by oxidizing an upper surface of said source/drain region using atomic oxygen” (claim 1) or “forming a composite barrier layer . . . comprising an oxide layer . . . by oxidizing approximately an entire upper surface of said source/drain region using atomic oxygen” (claim 40). This is because Yamazaki teaches first the formation of the insulating film 15 and only then the formation of source/drain regions 17. (Col. 19, lines 56-67; Col. 20, lines 1-29; Figures 2B-2D). In fact, in Yamazaki, insulating film 15 (which would arguably correspond to the oxide layer of the claimed invention) is “used as the gate insulating film,” and not as “an oxide layer over said source/drain regions” which in turn are formed “on opposite sides of said gate structure,” as in the claimed invention. Accordingly, Yamazaki is silent about “forming a source/drain region” and “*subsequently* forming an oxide layer over said source/drain region . . . by oxidizing an upper surface of said source/drain region using atomic oxygen” (claim 1) or about “forming spacers on sidewalls of said gate” and “*subsequently* forming a composite barrier layer over said source/drain region and said adjacent gate stacks including said spacers, said composite barrier layer comprising an oxide layer formed . . . by oxidizing approximately entire upper surfaces of said source/drain region using atomic oxygen” (claim 40).

Further, insulating film 15 of Yamazaki is “200-1500 Å thick, typically 1000 Å thick,” and not having a minimal thickness “of about 50 Angstroms to about 100 Angstroms,” as in the claimed invention. Applicants also note that “interlayer insulating film 18” of Yamazaki, which would also arguably correspond to the oxide layer of the claimed invention, is formed over “the entire surface” of the device and to a thickness of 3000 Å, and not over source/drain regions or to a minimal thickness “of

about 50 Angstroms to about 100 Angstroms," as in the claimed invention.

Accordingly, Yamazaki does not teach or suggest forming an oxide layer by oxidizing upper surfaces of a source/drain region using atomic oxygen, much less forming an oxide layer of a particular thickness by oxidizing upper surfaces of a source/drain region using atomic oxygen.

Wang and Yamazaki, whether considered alone or in combination, also fails to teach or suggest all limitations of amended independent claim 21. Wang and Yamazaki fail to teach or suggest forming "a composite barrier layer over said source/drain regions . . . comprising an oxide layer formed by oxidizing approximately entire upper surfaces of said source/drain regions using atomic oxygen, and a barrier layer formed over said oxide layer," as amended independent claim 21 recites. Both Wang and Yamazaki are silent about an oxide layer formed "by oxidizing approximately entire upper surfaces of said source/drain regions using atomic oxygen," as in the claimed invention. In addition, Wang teaches that etch barrier layer 24, which would arguably correspond to the barrier layer of the claimed invention, has a thickness "in the range between about 500 and 3000 Å" (col. 5, lines 32-34), and not "of about 30 Angstroms to about 150 Angstroms," as recited in independent claim 21. Yamazaki is silent about the formation of "a barrier layer . . . over said oxide layer," much less about the formation of "a barrier layer . . . over said oxide layer" and "having a thickness of about 30 Angstroms to about 150 Angstroms," as in the claimed invention.

Second, a person of ordinary skill in the art would not have been motivated to combine the teachings of Wang with those of Yamazaki, as the Office Action asserts. On one hand, the crux of Wang is "fabricating a (DRAM) having T or Y shaped capacitor with a high density and capacitance." (Col. 2, lines 32-34). For this, Wang teaches "fabricating a T or Y shaped capacitor which has less photolithographic and

etch steps than the conventional processes.” (Col. 2, lines 28-31). On the other hand, Yamazaki relates to the formation of a “modified silicon oxide film . . . used as the gate insulating” (col. 3, lines 22-23) which is subjected to an anneal treatment “at 400° to 700° C., preferably 450° to 650° C. in a highly reactive atmosphere of nitrogen oxide which is photoexcited or photodecomposed by ultraviolet rays.” (Abstract). Yamazaki emphasizes that “[n]itrogen oxide is made reactive by irradiation with ultraviolet rays, and the resulting reactive nitrogen oxide . . . reacts with the gate insulating film” (col. 6, lines 17-25) and points out that the annealing temperature “is not for the decomposition of the nitrogen oxide but for the penetration of active atoms and molecules into the silicon oxide film.” (Col. 6, lines 28-32). Thus, it is clear that the only element which Wang and Yamazaki have in common is their substrate on which their respective structures are formed. In addition, a person of ordinary skill in the art would not have been motivated to combine Wang, which teaches T or Y shaped capacitor for high density and capacitance, with Yamazaki, which teaches a specific anneal treatment of an oxide layer to be used as a gate insulating layer.

For at least these reasons, the Office Action fails to establish a *prima facie* case of obviousness, and withdrawal of the rejection of claims 1-8, 10, 11, 13, 14, 17-24, 27, 29-33, 35-43, 46, 48, 49 and 51-56 is respectfully requested.

Claims 9, 25, and 44 stand rejected under 35 U.S.C. § 103 as being unpatentable over Wang in view of Yamazaki as applied to claims 1-8, 11, 13-24, 27, 29-43, 46 and 48-56 above, and further in view of Lands et al. (“Lands”) (U.S. Patent No. 3,571,914). This rejection is respectfully traversed.

Lands relates to a “method for stabilizing a semiconductor device against spuriously induced changes in the conductivity characteristics at the surface of the semiconductor.” (Col. 1, lines 58-61). The crux of Lands is “the use of a silicon dioxide

layer formed by the oxidative decomposition of TEOS, by the pyrolysis of TEOS in an inert atmosphere, by the hydrogen reduction of silanes, or by other similar processes wherein the oxide layer may be uniformly doped by the desired stabilizing agent during formation of the oxide layer and stabilization of the surface of a semiconductor device.” (Col. 3, lines 27-34).

As noted above, neither Wang nor Yamazaki, whether considered alone or in combination, teach or suggest all limitations of amended independent claims 1, 21 and 40. Similarly, Lands fails to teach or suggest the formation of an oxide layer by “oxidizing an upper surface of a source/drain region using atomic oxygen” (claim 1) or by “oxidizing approximately entire upper surfaces of said source/drain regions using atomic oxygen” (claim 21). In addition, Lands fails to teach or suggest forming an oxide layer of a composite barrier layer by “oxidizing approximately an entire upper surface of said source/drain region using atomic oxygen,” as amended independent claim 40 recites. Lands is also silent about an oxide layer “having a thickness of about 50 Angstroms to about 100 Angstroms” and formed by oxidizing an upper surface of a source/drain region using atomic oxygen, as in the claimed invention.

Applicants also note that a person of ordinary skill in the art would not have been motivated to combine the teachings of Yamazaki with those of Land, as the Office Action asserts. As noted above, the crux of Yamazaki is the formation of a “modified silicon oxide film . . . used as the gate insulating” (col. 3, lines 22-23) which is subjected to an anneal treatment “at 400° to 700° C., preferably 450° to 650° C. in a highly reactive atmosphere of nitrogen oxide which is photoexcited or photodecomposed by ultraviolet rays.” (Abstract). On the other hand, the crux of Lands is the formation of a “phosphorous doped silicon oxide layer.” For this, Lands teaches “a silicon dioxide layer formed by the oxidative decomposition of TEOS, by the pyrolysis of TEOS in an inert atmosphere, by the hydrogen reduction of silanes, or by other similar processes.”

(Col. 3, lines 27-34). Accordingly, a person of ordinary skill in the art would not have been motivated to combine Yamazaki, which teaches a specific anneal treatment with reactive nitrogen oxide of an oxide layer to be used as a gate insulating layer, with Lands, which teaches oxidative decomposition or pyrolysis of TEOS to ultimately form a phosphorous doped silicon oxide layer. For at least these reasons, the Office Action fails again to establish a *prima facie* case of obviousness, and withdrawal of the rejection of claims 9, 25 and 44 is also respectfully requested.

Claims 12, 28, and 47 stand rejected under 35 U.S.C. § 103 as being unpatentable over Wang in view of Yamazaki as applied to claims 1-8, 11, 13-24, 27, 29-43, 46 and 48-56 above, and further in view of Kirimura et al. ("Kirimura") (U.S. Patent No. 6,383,869 B1). This rejection is respectfully traversed.

Kirimura relates to "a thin film forming method and a thin film forming apparatus, in which a deposition gas and a radical material having different dissociation energies are used for forming a thin film." (Col. 2, lines 46-49).

None of Wang, Yamazaki and Kirimura, whether considered alone or in combination, teaches or suggests all limitations of amended independent claims 1, 21 and 40. Claims 12, 28, and 47 are allowable for at least the reasons stated above for claims 1, 21 and 40, respectively. Therefore, withdrawal of the rejection of claims 12, 28, and 47 is also respectfully requested.

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Allowance of the application is respectfully requested.

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